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Development of a Common Distributed Computing Environment Testbed

A Proposal Submitted to the HPCMPO

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Outline of Talk

- DoD HPCMPO Metacomputing Working Group: Mission & Membership
- Early Influential National Computing Initiatives
- Emergence of a New Computing Paradigm: Grid Computing
- Development of a Common Distributed Computing Environment: A Proposal to HPCMPO
- Worthwhile Examples of Productivity Enhancing Capabilities
- Key Components of the Proposed DoD HPCMP CDCE Testbed Initiative
- Security Considerations: Issues, Problems & Solutions
- DoD HPCMP Grid-Related User Requirements Survey: Primary Tasks
- CDCE Testbed Initiative: Primary Tasks
- Engaging Users and Running DoD Flagship Applications: Paramount Objective

DoD HPCMPO Metacomputing Working Group (MCWG)

- **Mission**
  - **Assist the DoD HPCMP in its efforts to investigate important and matured grid-related advances that have wide applicability within the HPC Modernization Program**
- **Membership**
  - **MCWG is a collective body of representatives from all four Major Shared Resource Centers (MSRCs) and Allocated Distributed Centers (ADCs), Dedicated Distributed Centers (DDCs), and former Distributed Centers**
  - **Members are assigned to the MCWG by the Directors of respective Centers**

National Supercomputer Centers and DoD HPCMP Centers
Early National Computing Initiatives

- In a 1982 study, which led to the Lax Report, federal action was called for:
  - Increased access to supercomputers
  - Increased research in computational mathematics, software and algorithms
  - Research and development basic to the design and implementation of new supercomputing systems
  - Training of personnel in scientific and engineering computing
- In response to the Lax Report,
  - NSF, DOE and NASA created in the mid-eighties the so-called National Supercomputer Centers
  - At Congressional direction, DoD established in 1993 the High Performance Computing Modernization Program (HPCMP)

The Emergence of a New Computing Paradigm
Grid Computing

- **Continued access to and rapid upgrades of high-end computing centers and high-speed networking has given rise to pools of sophisticated users who need to:**
  - **Connect to multiple high-end computing centers**
  - **Access specialized databases and repositories, advanced simulation and visualization software, and remote instruments and sensors**
- **A key objective in this tightly woven Grid of linked and inter-operating resources is to**
  - **Allow individual users and geographically distributed teams to work effortlessly at multiple high-end computing centers without impairing their productivity**

Development of a Common Distributed Computing Environment A Proposal Submitted to the DoD HPCMPO

- **User Needs and Trends**
  - **A large community of DoD HPCMP users** are currently working on data- and computation-intensive problems **spread across multiple centers and services**
  - **For these users,** the non-uniformity of current computing environments **is a problem that needs to be addressed and resolved**
- **MCWG Action**
  - **MCWG has submitted a proposal to HPCMPO** for the development and operation of a **Common Distributed Computing Environment (CDCE) Testbed**
  - **The overall objective of the project is to allow users** to compute at ease at multiple high-end computing centers **without impairing their productivity**

Helping Users Compute at Ease at Multiple Computing Centers
Examples of Productivity Enhancing Capabilities

- **Develop an application at any site** and run the code at any other site
- **Run a job across multiple sites** using advanced scheduling & reservation capabilities
- **Run a code at any site** with data from any of the other sites
  - **A mode of computation** common to researchers working collaboratively
- **Move data between clusters**
- **Utilize intra-site high performance file systems** to access data from all nodes in a Linux cluster system
- **Exploit a common system to** track and respond to problems, hosting environment with a single contact **and** common accounting and billing

Key Components of the DoD HPCMP CDCE Testbed Initiative

- **Security Considerations**
  - **Configure a secure connectivity** to PKI-based Grid resources and utilities **external to HPCMP infrastructure**
- **DoD HPCMP Grid-Related User Requirements Analysis**
  - **Produce a Strawman Users Guide** detailing user needs, services and interfaces **followed by** a "Prioritized List" of services and interfaces
- **CDCE Testbed Operation**
  - **Acquire, and/or develop, install, test and evaluate** grid software and middleware recommended in the Prioritized List.
  - **Test & Evaluation** will be conducted by **engaging users** and **running DoD Flagship applications**

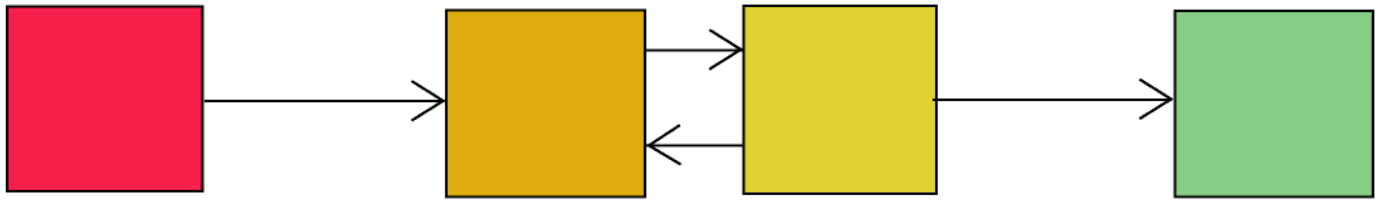
DoD HPCMP Common Distributed Computing Environment Testbed

A Proposal to the DoD HPCMPO

Security

User Requirements
Infrastructure

Implementation
Test & Evaluation



Deliverables

- Secure connectivity to PKI-based Grid resources & utilities
- White Paper
- Strawman User Guide
- Final Plan detailing recommended services and the CDCE Testbed configuration
- Implement services recommended in the Final Plan
- Engage users and run DoD Flagship Apps

Security Considerations
Problems and Proposed Solutions

- **Problems**
  - **All DoD HPCMP HPC Centers** are Kerberos authenticated sites
  - **In sharp contrast,** the open-standard Globus Toolkit middleware **and** the majority of current Grid advances **are PKI-based**
  - **Earlier MCWG efforts to Kerberize Globus Toolkit middleware** proved to be impractical
- **Proposed Solutions**
  - **Future DoD PKI CAC cards** having X.509 certificate with traceable root Certificate Authority (CA) **will be the method of choice**
  - **We are also including the KX.509 code** from NSF Middleware Initiative (NMI) **at early stages of the project**

Security Considerations
KX.509/KCA Code

- The Kerberized client-side KX.509/KCA code acquires a short-term X.509 certificate from the KCA server using existing Kerberos tickets for authentication
- Short-term certificate (also known as “proxy” certificate) is used to authenticate to PKI-based utilities and resources
- When the proxy certificate expires, a new one is generated by contacting the KCA service again and authenticating with valid Kerberos ticket as before
- KX.509/KCA code has been fully tested and evaluated at federal and academic institutions including
  - DOE Fermi National Accelerator Laboratory (Fermilab), Batavia, Illinois
  - High Performance Computing Center (HPCC) at USC
- Presently, over 500 users at Fermilab make use of KX.509/KCA code whereas HPCC/USC has the potential of supporting a user-base as large as 35,000 users

DoD HPCMP Grid-Related User Requirements Survey
Primary Tasks

- **Design a DoD HPCMP user requirements survey with special focus on matured grid advances that have wide applicability within the HPCMP**
- **Survey #1: Conduct an initial requirements survey among "major" DoD users with**
  - **Significant needs for HPC resources**
  - **Accounts at two or more HPCMP HPC sites**
- **Collect requirements followed by requirements analysis**
- **Survey #2: Add to the annual DoD HPCMP user requirements survey a section addressing DoD user needs for grid services and interfaces**
- **Collect requirements followed by requirements analysis of Survey #2**
- **Review/Prioritize requirements with the User Advocacy Group (UAG)**
- **Produce a Strawman Users Guide (SUG)**

DoD HPCMP Grid-Related User Requirements Survey
Primary Tasks (Continued)

- **Infrastructure Team Tasks**
  - **Define CDCE Testbed infrastructure requirements** collection process
  - **Collect requirements** followed by **requirements analysis**
  - **Review/Prioritize requirements** with the Engineering Design & Process Management Board (ED&PMB)

- **Joint SUG/Infrastructure Teams Workshop** to Produce an **Integrated Plan**
  - **The SUG and Infrastructure Teams will conduct** a joint requirements review followed by prioritization
  - **This will lead to an integrated** "Draft Plan"

- **Reviews** and Final **Plan Release**
  - **MCWG and UAG** will review **the Draft Plan**
  - **Feedback received from MCWG and UAG** is incorporated into the Draft Plan **to produce the "Final Plan"**
  - **Final Plan is submitted** to C-BOD for approval

CDCE Testbed Initiative
Primary Tasks

- **Acquire, and/or develop, install, test and evaluate** grid-related software and middleware recommended in the **Final Plan**

- **Recommended list of software and middleware** may include all or part of the following tools and capabilities:
  - **Common Software Stack** comparable to **TeraGrid's CTSS**
  - **Globus Toolkit middleware** from Argonne National Laboratory
  - **Storage Resource Broker (SRB):** Uniform interface to heterogeneous data resources
  - **Condor-G:** Intra-domain resource and job management
  - **Maui:** Advanced job scheduler used on TeraGrid's clusters and supercomputers

Common TeraGrid Software Stack (CTSS) Key Features

- Software stack is homogeneous across all sites except for differences driven by user needs
- Every package is versioned and the build/install/configure parameters are reproducible
- Software stack also has specific version, and is exposed routinely to unit/ integrated tests
- The most up-to-date CTSS includes:
  - Compilers
  - Grid Services
  - I/O
  - Math Libraries
  - Monitoring Services
  - MPICH Message Passing Libraries
  - OS, installation and drivers
  - Queuing and Resource Control
  - Scientific Visualization
  - User Environment and Tools

Current and Future CTSS Developments
Homogeneous to Heterogeneous

- **Originally designed to exploit homogeneity wherever possible** at participating TeraGrid sites
- **Development of a portable specification** is presently underway to support functionality and environment across
  - IA64
  - IA32
  - Power4
  - Alpha systems

The CDCE Testbed Initiative
Engaging DoD Users & Running DoD Flagship Applications

- **Ohio Supercomputer Center at Ohio State University will assist the technical team in identifying DoD users and DoD Flagship Applications**
- **Technical team will engage users in the following areas:**
  - **Test and evaluation of implemented software and middleware**
  - **Running DoD Flagship Applications on the CDCE Testbed**
- **Technical team will report DoD user experiences at UGC 2005**